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Buellia taishanensis sp. nov. and new *Buellia* records from Mt. Tai, China

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Abstract—Four species of the lichen genus *Buellia* are reported from Mt. Tai, Shandong, China. *Buellia taishanensis* is described as a new species, *B. chujana* and *B. halonia* are new to China, and *B. badia* has previously been reported from China. Descriptions are presented with morphological and chemical characters. After revising identifications from previous reports, we provide notes and a key to the four *Buellia* now confirmed from Mt. Tai.

Key words—*Ascomycota*, *Lecanoromycetes*, *Caliciales*, *Caliciaceae*, taxonomy

Introduction

Buellia De Not. (*Caliciaceae*, *Caliciales*, *Lecanoromycetidae*, *Lecanoromycetes*, *Pezizomycotina*, *Ascomycota*) is a cosmopolitan genus of lichenized fungi represented by more than 450 species (Kirk & al. 2008, Watanuki & al. 2017) and characterized by a crustose thallus, lecideine apothecia with black discs, a brown hypothecium, and brown septate ascospores.

Fifty *Buellia* species have previously been reported in China (Wei 1991, Aptroot & Seaward 1999, Aptroot & Sipman 2001, Aptroot & Sparrius 2003, Obermayer & al. 2004, Kondratyuk & al. 2013, Liu & Wei. 2013, Sun & al. 2013). During our study of *Buellia* from Mt. Tai, a world famous natural and cultural heritage, we collected a new species, described here as *Buellia taishanensis*, and recorded *B. chujana* and *B. halonia* as new to China.

Materials & methods

Specimens. All examined materials were collected from Mt. Tai, Shandong Province, and are deposited in Lichen Herbarium of the College of Life Sciences, Liaocheng University, Liaocheng, China (LCU). Morphological examinations were conducted following protocols set forth in Jia & Wei (2016).

DNA extraction, amplification, and sequencing. DNA was extracted from ascomata and thallus fragments using the DNAsecure Plant DNA Kit following the manufacturer's protocol. The ITS1+5.8S+ITS2 nrDNA region was amplified using the ITS1F and ITS4 primers (White & al. 1990, Gardes & Bruns 1993) in 25 μL volumes containing 12.5 μL 2×Taq PCR MasterMix, 1 μL 10μM solution of each primer, 0.5 μL genomic DNA, and 10 μL ddH_2O. Thermocycling parameters comprised initial denaturation at 94°C for 3 min, 35 cycles of denaturation at 94°C for 30 s, annealing at 54°C for 30 s, extension at 72°C for 1 min, and a final extension at 72°C for 5 min. The PCR products were screened on 1% agarose gels stained with ethidium bromide and sequenced using a ABI 3700 Sequencer. Newly generated sequences were submitted to GenBank.

Taxonomy

Buellia taishanensis Q.D. Wang & Z.F. Jia, **sp. nov.** Pl. 1

Fungal Name FN570500

Differs from *Buellia concinna* by its smaller ascospores and the absence of gyrophoric, lecanoric, and orsellinic acids.

Type: China. Shandong Province, Taian City, Mt. Tai, Jade Emperor Summit, 36°15′N 117°06′E, alt. 1510 m, 23/VIII/2017, Q.D. Wang TS1745 (**Holotype**, LCU; GenBank MG250190).

Etymology: The specific epithet *taishanensis* refers to the type locality of the new species, Mt. Tai (Taishan).

Thallus saxicolous, crustose, grey or grey-brown; thin or lacking cortex; surface rough and non-pruinose; medulla white.

Apothecia lecideine, often abundant, sessile; disc black, epruinose, at first plane, marginate, later becoming convex, thinly marginate, 0.5–0.8 mm diam; exciple *aethalea*-type, 15–35 μm thick; epithecium brown, 10–15 μm; hymenium 40–60 μm tall, hyaline, without oil droplets, paraphyses 1.5–2.5 μm diam; hypothecium dark brown. Asci cylindrical to clavate, 25–45 × 9–15 μm, 8-spored. Ascospores brown to dark brown, *Buellia*-type, ellipsoid, 1-septate, 10–12 × 4–5 μm. Pycnidia not observed.

Chemistry: Norstictic acid (by TLC).

Additional specimen examined: **CHINA. Shandong Province**, **Taian City,** Mt. Tai, Jade Emperor Summit, alt. 1510 m, 23/VIII/2017, Q.D. Wang TS1751 (LCU).

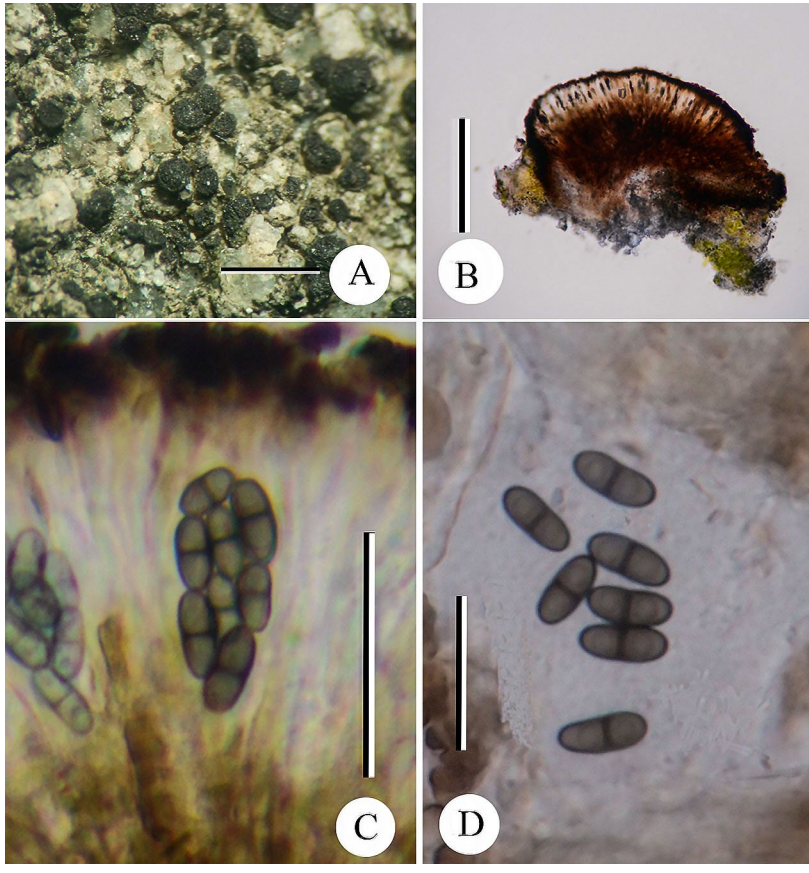

Plate 1. *Buellia taishanensis* (holotype, LCU Wang TS1745). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascus containing ascospores; D. Ascospores. Scales: A = 2 mm; B = 100 μm; C = 50 μm; D = 20 μm.

Remarks: *Buellia taishanensis* is morphologically similar to *Buellia concinna* Th. Fr., which can be distinguished by its larger (15–21 × 7–9 μm) ascospores and production of gyrophoric, lecanoric, and orsellinic acids (Bungartz & al. 2004).

Buellia badia (Fr.) A. Massal., Mem. Lichenogr.: 124 (1853).

Thallus saxicolous, crustose, bullate to subsquamulose (becoming distinctly squamulose), continuous; surface deep brown, smooth, epruinose; medulla white.

Apothecia lecideine, 0.3–0.7 mm diam, sessile; disc black, epruinose, initially plane, usually becoming strongly convex; exciple narrow, *aethalea*-type, 15–40 µm thick; epithecium brown, hymenium 50–75 µm tall, hyaline, without oil droplets, paraphyses 2–3 µm diam. Asci cylindrical to clavate, 8-spored. Ascospores brown to dark brown, *Bacidia*-type, ellipsoid, 1-septate, 12–15 × 6–8 µm. Pycnidia not seen.

Chemistry: No lichen compounds detected by TLC.

specimen examined: **CHINA. Shandong Province**, **Taian City,** Mt. Tai, Hurrahing Gate, alt. 850 m, 23/VIII/2017, Q.D. Wang TS1777 (LCU; GenBank MG250192).

Remarks: Our Chinese specimen of *Buellia badia* has very slightly larger ascospores in the lower range than previously described (10–15 × 5–8 µm; Bungartz & al. 2007) but otherwise has similar morphology and chemistry. *Buellia badia* shares a similar chemistry with *B. imshaugii* Hafellner, which differs by its grayish brown thallus and *dispersa*-type exciple. *Buellia badia* has been reported from Europe, North Africa, North America, South Korea, and New Zealand (Scheidegger 1993, Bungartz & al. 2004, Wang & al. 2016). In China, the lichen has previously been reported in Liaoning, Heilongjiang, and Taiwan (Kondratyuk & al. 2013, Qi & al. 2015, Aptroot & Sparrius 2003); new to Shandong.

Buellia chujana Xin Y. Wang, S.Y. Kondr., L. Lökös & J.S. Hur, Mycobiology 44(1): 16 (2016). Pl. 2

Thallus saxicolous, crustose, rimose, continuous; brown or dark brown; areoles 0.2–0.8 mm across, with a clear thallus margin, surface smooth and non-pruinose, medulla white.

Apothecia often abundant; disc black, epruinose, plane convex; 0.1–0.5 mm diam., immersed to sessile; exciple narrow, 15–40 µm thick; epithecium brown; hymenium 30–50 µm tall, hyaline, without oil droplets, paraphyses 2–3 µm diam. Asci cylindrical to clavate, 8-spored. Ascospores brown to dark brown, *Bacidia*-type, ellipsoid, 1-septate, 8–11 × 6–8 µm. Pycnidia not seen.

Chemistry: Perlatolic acid (by TLC).

Selected specimens examined: **CHINA. Shandong Province**, **Taian City,** Mt. Tai, Houshiwu, alt. 1300 m, 23/VIII/2017, Q.D. Wang TS1767 (LCU; GenBank MG250191); Shanziya, alt. 590 m, 28/X/2006, Y.N. Hou TS1010 (LCU); Linghan Peak, alt. 300 m, 13/V/2007, J. Li TS1040 (LCU); Hongdelou, alt. 1510 m, 8/X/2008, C.M. Wang TS1323, C.C. Jin TS1324 (LCU); Tianzhu Peak, alt. 750 m, 8/XI/2008, M.H. Cao TS1354 (LCU); Aolai Peak, alt. 550 m, 3/XI/2011, R.C. Ren TS1440 (LCU); Tianzhu Turtle, alt. 980 m, 23/VIII/2017, Q.D. Wang TS1772, TS1774 (LCU); Hurrahing Gate, alt. 850 m, 23/VIII/2017, Q.D. Wang TS1778 (LCU).

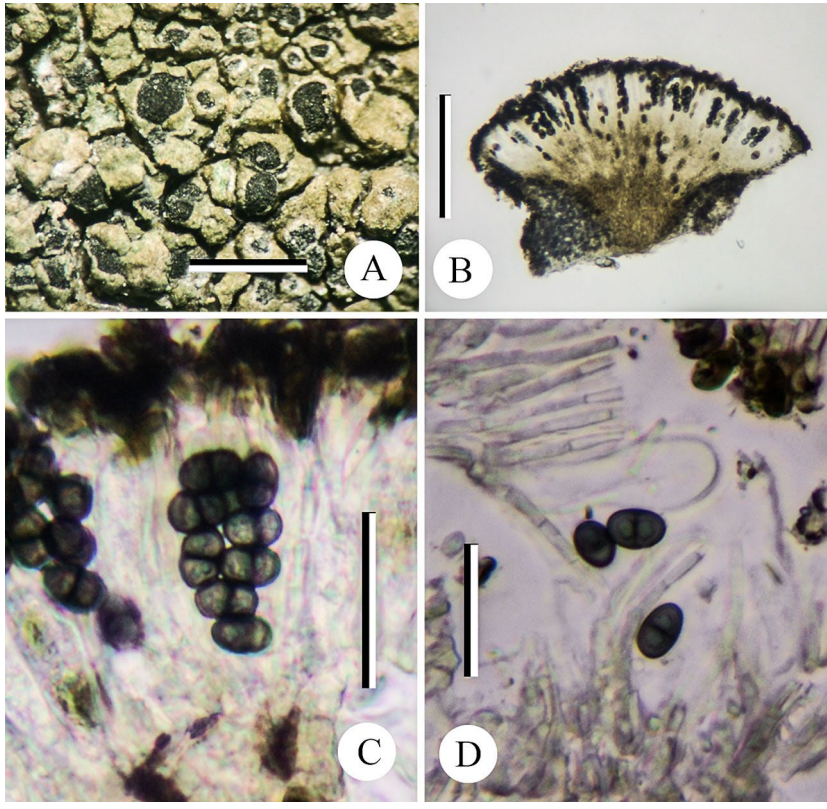

Plate 2. *Buellia chujana* (LCU Wang TS1767). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascus containing ascospores. D. Ascospores. Scales: A = 1 mm; B = 100 µm; C = 50 µm; D = 20 µm.

Remarks: Our Chinese specimen of *Buellia chujana* has a thinner hymenium than previously described (50–60 µm; Wang & al. 2016), but otherwise has similar morphology and chemistry. *Buellia chujana* is morphologically similar to *B. nashii* Bungartz, which can be distinguished by its subsquamulose thallus containing atranorin and norstictic acid as the main compounds. Previously known only from South Korea (Wang & al. 2016), *B. chujana* is new to China.

Buellia halonia (Ach.) Tuck., Lich. Calif.: 26 (1866). Pl. 3

Thallus saxicolous, crustose, rimose; areoles yellowish green to pale yellow; thallus surface smooth and epruinose.

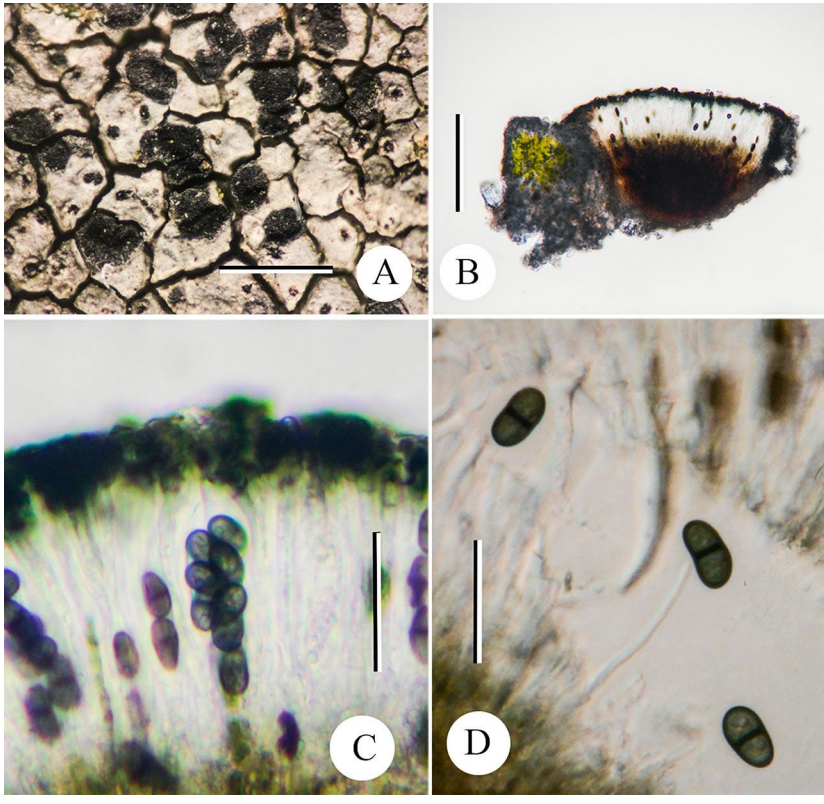

Plate 3. *Buellia halonia* (LCU Wang TS1749). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascus containing ascospores. D. Ascospores. Scales: A = 1 mm; B = 100 µm; C = 50 µm; D = 20 µm.

Apothecia epruinose; disc black, plane, initially immersed, soon bursting through thallus surface and becoming adnate to sessile, 0.2–0.5 mm diam; exciple 25–50 µm thick; epithecium brown; hymenium 40–60 µm tall, hyaline, without oil droplets, paraphyses 2–3 µm diam. Asci cylindrical to clavate, 8-spored, *Bacidia*-type. Ascospores initially olive, brown at maturity, oblong to ellipsoid, 1-septate, 13–15 × 6–8 µm. Pycnidia not seen.

Chemistry: Atranorin and norstictic acid (by TLC).

Specimen examined: **CHINA. Shandong Province, Taian City,** Mt. Tai, Jade Emperor Summit, alt. 1510 m, 23/VIII/2017, Q.D. Wang TS1749 (LCU; GenBank MG250193).

Remarks: The morphology and chemistry of our Chinese specimen agrees with that described by Bungartz & al. (2004). *Buellia halonia* is morphologically similar to *B. mamillana* (Tuck.) W.A. Weber, which differs by its pruinose thallus with norstictic and connorstictic acid as the main compounds. Previously known from North America, South Africa, Australia, Chile, and South Korea (Bungartz & al. 2004, 2007; Wang & al. 2016), *B. halonia* is new to China.

Notes on previous reports of *Buellia* from Mt. Tai

Four *Buellia* species previously reported from Mt. Tai by Sun & al. (2013) are revised as follows: *B. atrocinerella* (Nyl.) Scheid. represents a misdetermination and is revised here as *B. chujana;* specimens TS1324 and TS1354 (previously cited under *B. centralis*) are redetermined here as *B. chujana,* while specimen TS231 must still be tested for the presence of norstictic acid; and the specimens cited as representing *B. ocellata* (Flörke ex Flot.) Körb. and *B. spuria* (Schaer.) Anzi possess lecanorine apothecia and must be referred to a different lichen genus.

Key to the species of *Buellia* from Mt. Tai

1a. Ascospores <12 µm long 2
1b. Ascospores >12 µm long 3
2a. Norstictic acid present; ascospores 10–12 × 4–5 µm ..... *B. taishanensis*
2b. Perlatolic acid present; ascospores 8–11 × 6–8 µm ..... *B. chujana*
3a. Lichen compounds absent ..... *B. badia*
3b. Atranorin and norstictic acid present ..... *B. halonia*

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